

ENGINEERING CYANOBACTERIA FOR USE AS PHOTOSYNTHETIC CHEMICAL FACTORIES

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Finding a sustainable alternative for today's petrochemical industry is a major challenge facing chemical engineers and society at large. To be sustainable, routes for converting carbon dioxide and light into organic compounds for use as both fuels and chemical building blocks must be identified, understood, and engineered. Furthermore, these routes must be economically competitive with current and future fossil fuel sources and not irreversibly deplete other natural resources (e.g. food, water). Terrestrial lignocellulosic biomass (e.g. agricultural wastes, energy crops, and forestry reserves) has been the subject of extensive R&D for use as a renewable carbon feedstock for producing biofuels and displacing petrochemicals. Despite this significant effort, many challenges to commercialization remain. These problems include cultivation costs, transportation, processing, and a mismatch between available supply and current petrochemical demand. A possible alternative and/or supplement is the use of aquatic phototrophs such as eukaryotic algae or prokaryotic cyanobacteria to directly produce chemicals and biofuels, skipping the biomass middle-man. In this talk, I will describe my group's efforts to develop *Synechococcus* sp. strain PCC7002 as a model phototroph for chemical production from sunlight and carbon dioxide. PCC7002 is attractive because it is one of the fastest growing photoautotrophs, halotolerant, naturally transformable, and well represented in the literature. Our initial attempts to apply metabolic engineering in this strain failed miserably due to a lack of reliable genetic and synthetic biology tools (e.g. segregation drivers, controllable promoters, terminators). To address this problem, we assembled a toolbox for working with PCC7002 and have applied the tools to engineer strains capable of producing lysine, lactate, and glycogen. In this talk, I will describe our toolbox development (promoters, CRISPRi, CRISPR genome editing), our ongoing metabolic engineering studies, and the remaining obstacles to deploying cyanobacterial biorefineries.

Biosketch:

Brian received his bachelor's degree in Chemical Engineering from Cornell University in 2000. and earned his PhD in Chemical Engineering in 2005 from the University of California-Berkeley under the supervision of Jay Keasling. Brian's thesis research focused on developing methods of controlling gene expression in bacteria that could be applied to enhancing the biosynthesis of pharmaceuticals. After graduating, he accepted a postdoctoral fellowship in the laboratory of David Sherman at the University of Michigan, where he studied how six *Bacillus anthracis* enzymes assemble a natural product essential for iron acquisition and pathogenesis. Brian is currently the Walter J. and Cecile Hunt-Hougen Faculty Scholar and Associate Professor of Chemical and Biological Engineering with appointments in Biomedical Engineering, the Microbiology Doctoral Training Program, and the graduate program in Cell and Molecular Biology. Brian's research has been recognized with young investigator awards from 3M, NSF (CAREER), DOE (Early Career), the Air Force Office of Scientific Research (AFOSR-YIP), *Biotechnology and Bioengineering* (Daniel IC Wang Award), the Vilas Trust (Early Career and Vilas Associate Awards) and Purdue University (Mellichamp lectureship). Brian also received the Benjamin Smith Reynolds teaching award from the UW-Madison College of Engineering for his efforts to introduce undergraduates to biotechnology.

